Direct and Indirect Climate Change Impacts in the Land-Use Sector

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Rapid exploitation of fossil resources has resulted in a massive release of greenhouse gases (GHG) into the atmosphere. This anthropogenic perturbation of the complex climate system could result in a change of global climate patterns unprecedented in the past millennium. As such, further climatic change poses a serious threat to a broad range of natural systems and economic sectors. The land-use sector, with agriculture in particular, is greatly challenged by the new weather conditions. Hence, adequate action is required in order to adapt and also to prevent potential negative impacts on the sector's services.

This thesis aims to assess the direct and indirect impact of climate change in the land-use sector, and to evaluate the associated economic distributional effects. Direct economic impacts from climate change in the agricultural sector are manifested through alterations of crop yields and consequent shifts in agricultural markets including changes in consumer and producer rents. Beyond agriculture, changes in carbon stocks in natural vegetation and soils are also directly affected by climate change. At the same time, they offer a great GHG reduction potential in a land-based climate change mitigation policy. Mitigation measures are needed in all sectors, but they could also lead to negative economic effects and manifest as indirect impacts of climate change, since a comprehensive mitigation policy could rebound in agricultural markets by adding more pressure to production activities. Aside from the aim of assessing impacts, this thesis has a second goal, that of identifying those measures that could reduce the magnitude of such economic consequences.

The assessment of direct and indirect climate change economic impacts is accomplished in a broad scenario analysis employed in the Model of Agricultural Production and its Impacts on the Environment (MAgPIE). MAgPIE is a partial equilibrium model of the agricultural sector that optimizes land-use patterns such that agricultural demand is fulfilled at the minimal production cost. Biophysical inputs for MAgPIE with climate change impacts (crop yields, water availability and carbon content) come at a high spatial resolution, and as such influence production systems subject to regionally defined economic constraints. For this thesis, the existing framework is extended by an analysis of market shocks and shifts in economic surpluses.

The main findings of the thesis suggest that a strong climate change effect on crop yields could cause significant global agricultural welfare loss by the end of the century. Geographic regions will be differently affected by climate change, with more losses in tropical areas. Additionally, the weight of economic impacts will be higher for food consumers than for food producers. However, a land-use based mitigation policy could greatly contribute to the reduction of the direct impacts. Still, achieving the land-based mitigation potential could considerably affect land-use and the dynamics of terrestrial carbon stocks. Under a GHG emission tax policy, land-use change carbon emissions could be almost entirely avoided. However, residual emissions from agricultural production systems (methane and nitrous-oxide gases) would still remain even if emission taxing mechanisms were applied, while the negative mitigation policy effects would reflect strongly in higher production costs and consequently increasing food prices.

Particular measures can be implemented to alleviate the negative impacts from climate change and mitigation action. More openness in international agricultural trade could considerably reduce global and regional losses. Food demand management, changing diet patterns and reducing waste, all point to ways not only of reducing GHG emissions, but also of relieving the pressure of agricultural markets. GHG reduction measures can also be diversified in order to prevent impacts of a mitigation policy; for example a lower than optimal GHG tax for the non-CO_2 emissions in the agricultural sector would trigger emissions reduction to the full potential without threatening food price stability. In the context of food security, these measures should be an integral part of any policy portfolio aiming at both the mitigation of climate change and the avoidance of direct and indirect climate change impacts on the stable utilization of food.